CHICOPEE FALLS

LOCAL PROTECTION PROJECT

SPECIAL STUDY

SLOPE PROTECTION IN PROJECT LIMITS

7

PREPARED FOR

U. S. ARMY ENGINEER DIVISION

NEW ENGLAND

OCTOBER, 1962

By

GREEN ENGINEERING AFFILIATES, INC.
BOSTON MASSACHUSETTS

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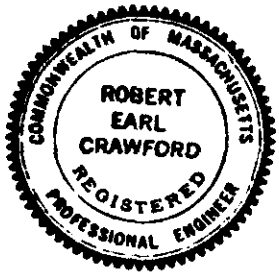

Green Engineering Affiliates, Inc. · ENGINEERS

177 MILK STREET • BOSTON 9, MASS.
Telephone: Liberty 2-5785
(Area Code 617)

November 2, 1962

U. S. Army Engineer Division, New England
424 Trapelo Road
Waltham 54, Massachusetts

ATTN: Mr. John Wm. Leslie, Chief
Engineering Division

SUBJ: Local Protection Project
Chicopee Falls, Massachusetts

Gentlemen:

The accompanying report is submitted in accordance with our contract. This constitutes final submission of the Special Study - Slope Protection In Project Limits, Line Item No. 4 of our contract.

Very truly yours,
GREEN ENGINEERING AFFILIATES, INC.

R. E. Crawford

Robert E. Crawford
Vice President

REC/dta

Encl.

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LIST OF PLATES

CHICOPEE FALLS
SPECIAL STUDY
PROTECTION IN PROJECT LIMITS

I. INTRODUCTION

A. Purpose - The purpose of this study was to make a condition survey of the right bank of the river within the project limits, in its natural state and as it will exist after the project is completed; to develop basic design criteria, methods and costs for stabilizing and/or providing slope protection; and to provide a permanent record thereof.

B. Scope - This report presents a description of the present conditions including the physical characteristics of the right bank and the hydraulic regimen in the river, a description of the project, including characteristics of the proposed right bank and an analysis of the anticipated hydraulic regimen, analyses and discussion of the effects of the project on the right bank, and conclusions and recommendations. Plates showing the project, results of soils and hydraulic analyses, and photos of typical areas and areas of special interest are appended.

II. EXISTING CONDITIONS

A. Right Bank - The general configuration of the stream and banks is shown on Plate 2, and Plates 5 through 9 show photos along the right bank. The approximate positions and bearings from which the photos were taken are shown on Plate 2.

On Plate 3 are shown four typical cross-sections along the right bank which are considered to be representative of existing conditions, based on a reconnaissance of the entire area. The sections were selected at specific locations, with the appropriate design flood water elevations shown for those locations. There is usually a gradual transition in profile between the sections shown.

In general, the height of slope is from 50 to 75 feet above the river bottom, increasing in height in a downstream direction to approximately Section 30. The slope generally varies from 1 on 1.6 to 1 on 1.3 with a few somewhat steeper slopes near the river's edge, due apparently to river erosion. With the exception of the area in the vicinity of Section 24, the slopes are usually covered with a fairly dense growth of brush and trees. Specific comments are noted on each section in Plate 3.

At Section 24 ±, there is a steep slope where, for a distance of some 240 feet along the river, the medium to fine sand stands at its natural angle of repose indicating that sloughing has occurred and is still continuing at a slow rate. Sand from the upper portion, some 70 feet above river

level, has sloughed down over the entire slope, with some buildup of materials at the toe of slope. As a result, very little vegetation has taken root in this area. The average angle of the slope is approximately 35 degrees above the horizontal. The material is a light brown medium to fine sand.

The Modified Standard Project Flood elevations as well as the observed levels of the 1955 flood are shown on each section, Plate 3. The ratio of the height of the design flood level to the total height of slope above river bottom decreases from approximately 0.5 at the upstream end to 0.3 at the lower end of the area under discussion.

In general, there is some evidence of erosion by the river during recent flood stages, particularly in the vicinity of Section 30, where there is a steep slope at the river's edge. However, further erosion of those lower slopes would be of little consequence and would not be expected to precipitate any major slides which would result in appreciable loss of ground at the top of slope or blocking of the effective width of the stream.

To check on the stability of the existing slopes during flood stages, the right bank in the vicinity of Section 9 was selected for investigation. At this point, the design flood level extends nearly half way up the existing slope. It is assumed that soils of the entire slope are homogeneous and consist of medium to fine sand. Further downstream, the natural slopes are just as steep, and occasionally steeper,

but they are felt to be less critical with respect to a failure due to sudden drawdown of the river level. This is concluded since the previously mentioned ratio of flood height to total height of slope is less, and also because compact glacial till overlies the bedrock and extends upward through portions of the zone of flooding. This material would be much more stable.

The adopted soil data values were as follows: saturated unit weight, 125 pcf; moist unit weight, 110 pcf; angle of internal friction, 35 degrees; and no cohesion. The extreme case of "sudden drawdown" from the maximum flood stage to normal river level was investigated. This condition assumes that the water level drops so rapidly that drainage does not take place, so that the soil above the circular arc surface remains fully saturated, for purposes of determining the tangential driving forces. The forces normal to the arc are reduced by the hydrostatic pressures.

Two trial failure circles were assumed as indicated on Section 9, Plate 3. The computed Factor of Safety for Trial No. 1 is 1.10, and for Trial No. 2 is 1.36, both for the "sudden drawdown" case. In addition, the condition of a submerged slope under design flood level was analyzed for Circle No. 2. The computed factor of safety is 1.54. No further analyses are considered necessary.

As for the open area near Section 24, it is expected that surficial sliding of the sand will continue as a result

of wind erosion, surface runoff, freezing, thawing, etc. The slope should not become much steeper inasmuch as the sand has reached its normal angle of repose. Some losses of material can be expected along the toe of slope due to erosive action of the river during flood conditions, together with possible minor losses due to rapid drawdown. Again, there is no known overall stability problem which would result in any major blockage to the river. Minor losses at the toe due to materials carried downstream would be quickly replaced by material sliding down the surface from above.

B. Hydraulics - Stage profiles are shown on Plate 4 for the 1955 flood (41,400 CFS) and for the Modified Standard Project Flood (70,000 CFS). The 1955 stages are from observed water levels; the Modified Standard Project Flood stages were determined by backwater analysis and velocity profiles for this flood are included on Plate 4.

As shown by the Plates, the river is generally in a rough and steep bed upstream of Section 17, becoming wider and assuming a more gradual bottom profile downstream. Roughness coefficients were fixed by reconnaissance at .045 upstream of Section 8, .040 from Section 8 to Section 16, and .035 downstream of Section 17, for the natural channel.

The overall alignment of the river through the project area curves away from the right bank to Section 50, then reverses with the right bank at the inside of a curve from Section 50 downstream. Three constrictions occur in the vicinity of Section 23, at a small weir of U. S. Rubber Company, near

Section 48, and in the vicinity of Section 62. The constrictions at Sections 23 and 62 are associated with sharp bends in the river. The weir is presently in disrepair, but it is assumed that it will be rebuilt in the future to approximately elevation 78.5 more or less whether the Project is completed or not.

Average natural velocities in the main channel are estimated (at Modified Standard Project Flood) to vary between 9 and 17 feet per second. These are, in most reaches, comparable to velocities after construction of the Project, differing notably at the constrictions. Flow characteristics for moderate or smaller floods are expected to show only minor differences between natural and project velocities.

III. DESCRIPTION OF PROJECT

A. Channel and Banks - The Project consists of a dike and wall line of protection constructed along the left bank to protect factories situated on the narrow flood plain. Downstream of Section 33, the dike is located in the existing river channel, and the right bank is excavated to furnish borrow and provide a new 200 foot channel. This excavation provides the primary source of borrow for the earthwork structures. The bottom of the widened river portion and at least one-half the height of slope will be excavated in a very compact glacial till material. Overlaying the till are various transitional layers of sandy and gravelly materials, over which lies a stratum of sand, up to eight feet in thickness. Three borings, as well as a series of twenty shallow test pits, have been taken in the area to determine the extent and characteristics of these materials.

The proposed cross-section is shown at Section 40, Plate 3. A berm, fifteen feet in width, will be maintained at Elevation 81. Below this berm a 1 on 2 slope is carried to the channel floor. A 1 on 2-1/2 slope extends upward the full height of slope above the berm. At this section, the total height of slope is approximately 30 feet above the berm. The berm provides access along the river edge for maintenance and also a shelf for retention of materials which might slide down from above. The berm is pitched toward the river to facilitate runoff.

There are no apparent stability problems concerning the new right bank slopes.

B. Hydraulics - Plate 4 presents stage and velocity profiles for the river with the Project completed, for the Modified Standard Project Flood (70,000 CFS) and for a moderate flood of 10-year frequency (10,000 CFS). Analysis was by backwater computations, using "n" for the natural channel as given above. For the improved channel, "n" was taken as .030. Allowance was made for bend losses.

Average velocities are generally 10 to 12 feet per second at design flood stage in the improved channel downstream of Section 33. This represents a decrease in velocity in the vicinity of Section 62 due to removal of the constriction there. A local peak velocity of 14 feet per second at the U. S. Rubber Company weir is expected when the weir is reconstructed, whether the project is constructed or not. In the area between Section 33 and the old tailrace, Section 29, velocities are about 10 fps. Further upstream, the velocities increase progressively to a peak of about 23 fps at Section 23 and then are reduced progressively around the bend to about 12 fps at Section 16. Further upstream, average velocities generally vary between 11 and 14 fps, primarily dependent upon the degree of channel constriction.

The average high velocity of 23 fps at Section 23 is due to a condition of critical flow estimated to be in this area due to the constriction of the channel. Analysis has

been made of specific head diagrams for upstream and downstream sections which has indicated that the critical flow condition will be localized to the vicinity of Section 23 and that, under the conditions of the computed average flow, transition to supercritical and formation of a hydraulic jump would not be likely to occur over the entire cross-section. If favorable field conditions made supercritical flow possible, then an undular or submerged type jump might be expected. Most possible, however, is the partial transition of flow to supercritical, due to the non-uniform velocity distribution around the bend, and the subsequent partial and incomplete jump. In order to minimize the probability of occurence of supercritical flow and at the same time to provide some protection and control for a possible jump, the project plan includes heavy riprap cover over an area 300'long in the vicinity of Sections 23 and 24. This cover extended up the lower slope of the right bank will give some protection to this section.

The velocity distribution in the channel is expected to be most seriously affected in the bend area around the Chicopee Manufacturing Corporation buildings. High velocity concentrations are expected to be alongside the floodwall and dike upstream of Section 23, then move nearer to the right bank between Sections 25 and 33, return along the dike between Sections 36 and 41 and head nearer to the right bank towards Section 52. Generally, high velocities may be ex-

pected to range up to about 25% higher than the average for most of the channel, except around the bend at the Chicopee Manufacturing Company where high local velocities may range up to or even exceed 50% above the average.

IV. ANTICIPATED EFFECTS OF PROJECT ALONG RIGHT BANK

A. Natural Bank - Adverse effects on natural banks would be due to erosion, since there would be no significant change in drawdown or other stability characteristics. As discussed above, there is generally no serious erosion problem anticipated where velocities do not change markedly. Dikes and walls are located on the flood plain near the line of protrusion of the buildings. The more regular left bank provided by the project should result in more regular velocity distribution than in the natural channel. Since velocities do not increase by marked amounts except in critical areas where stone protection is provided, the Project should have little effect on the natural slopes along the right bank.

It should be noted that the 1955 flood caused minor erosion along the right bank; the higher velocities attendant upon the much larger project design flood, shouldit occur, may be expected to cause some erosion with or without the Project, but no serious effects should result therefrom.

B. New Bank at Channel Widening - No erosion protection is considered necessary since the compact glacial till would normally resist the anticipated erosive forces of the design flood.

No interceptor ditches along the top of the slope are required. At those points where the natural topography above the cut slope would result in concentrated flow over the edge, paved surfaces to carry this flow down over the

face of the slope to the river will be required.

It is recommended that the surface areas of the cut slopes be covered with at least a six-inch layer of topsoil and seeded. The existing topsoil and forest litter would be stripped from the original area and stockpiled for this use.

At the right abutment of the reconstructed U. S. Rubber Company weir, stone slope protection will be required for a short distance.

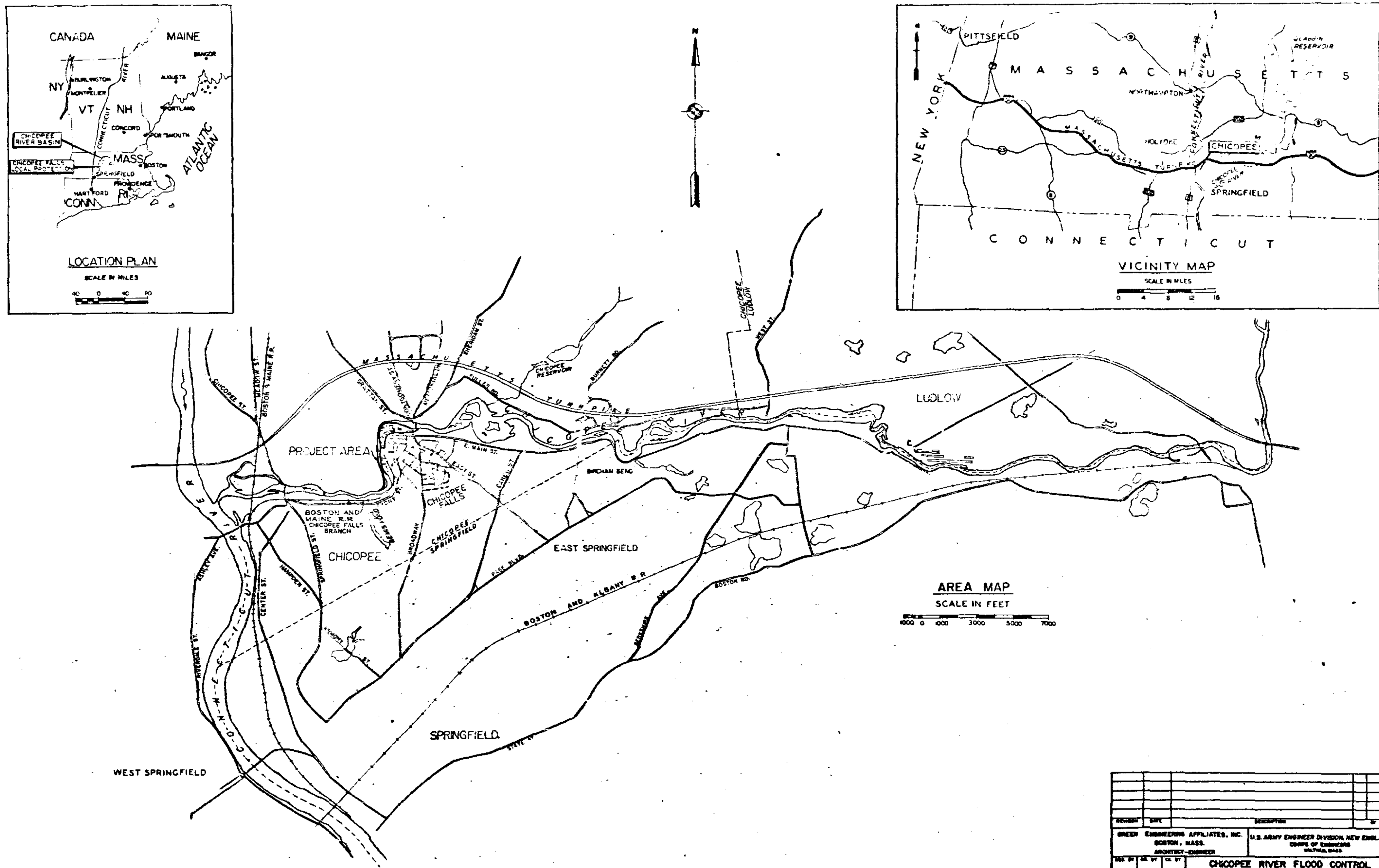
V. CONCLUSIONS

It is concluded that no significant adverse effects to the right bank are to be anticipated as a result of this Project. Critical areas will be protected as part of the normal construction of the Project.

VI. RECOMMENDATIONS

No measures solely for protection of the right bank beyond those attendant upon normal construction practice, as included in the Project, are considered justified and none are recommended.

CORPS OF ENGINEERS



REVISION	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC.
BOSTON, MASS.
ARCHITECT-ENGINEER

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
LOCATION PLAN

CHICOPEE RIVER MASSACHUSETTS

DES. BY | DR. BY | CK. BY

SUBMITTED: ARCHITECT - ENGINEER

PROJECT ENGINEER

APPROVAL RECOMMENDED: CHIEF, ... BRANCH

APPROVAL RECOMMENDED: CHIEF, P. & S. BRANCH

APPROVED: CHIEF, ENG. ... DIVISION

DATE

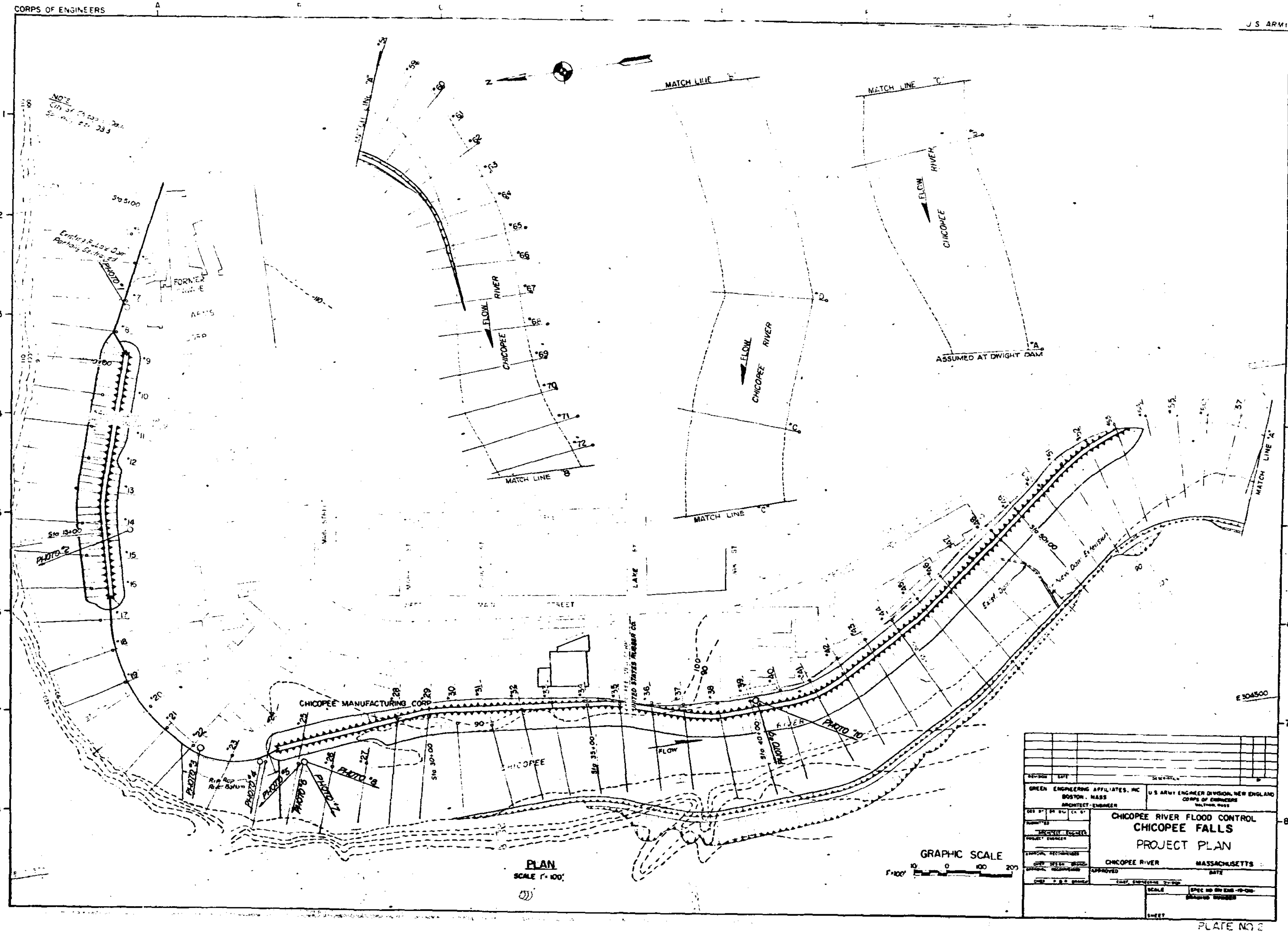
SCALE

SPEC. NO. CIV. ENG. -19-...

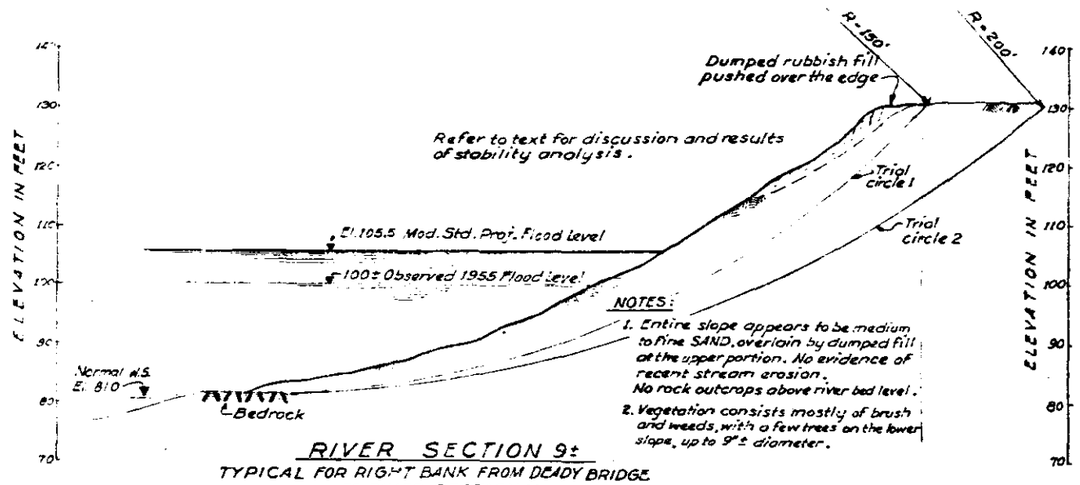
DRAWING NUMBER

SHEET

PLATE

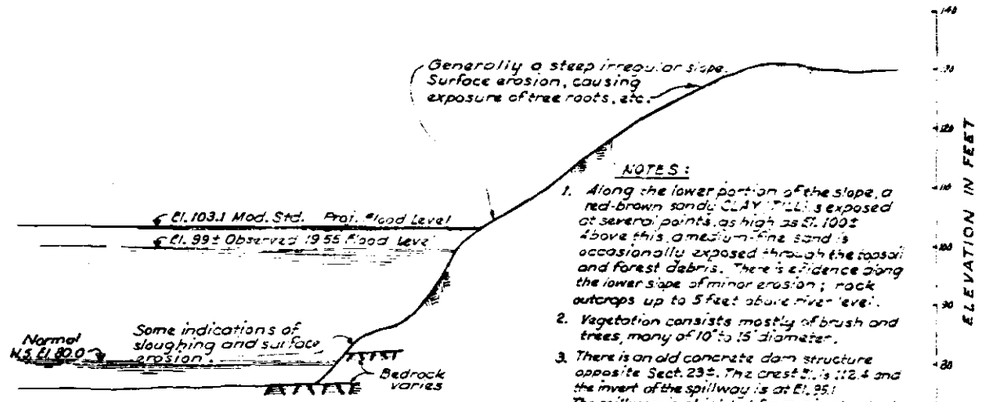

CORPS OF ENGINEERS
U.S. ARMY
MATCH LINE "A"
MATCH LINE "B"
MATCH LINE "C"
ASSUMED AT DWIGHT DAM
FLOW
CHICOPEE RIVER
CHICOPEE MANUFACTURING CORP.
UNITED STATES RUBBER CO.
MAIN STREET
PHOTO 2
PHOTO 3
PHOTO 4
PHOTO 5
PHOTO 6
PHOTO 7
PHOTO 8
PHOTO 9
PHOTO 10
Sta 15+00
Sta 30+00
Sta 35+00
Sta 40+00
Sta 80+00
New Dike Extension
Exist Dike
E 304500
PLAN
SCALE 1" = 100'
GRAPHIC SCALE
GREEN ENGINEERING AFFILIATES, INC
BOSTON, MASS
ARCHITECT-ENGINEER
U.S. ARMY ENGINEER DIVISION, NEW ENGLAND
CORPS OF ENGINEERS
CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
PROJECT PLAN
CHICOPEE RIVER
MASSACHUSETTS
APPROVED
SCALE
SHEET
PLATE NO 2

CORPS OF ENGINEERS — U.S. ARMY



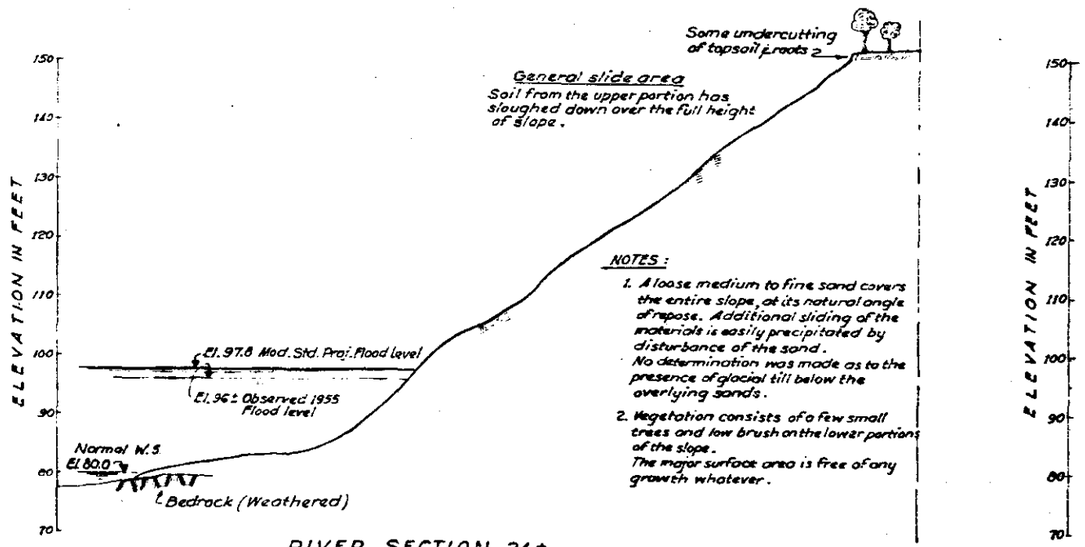
RIVER SECTION 9±

TYPICAL FOR RIGHT BANK FROM DEADY BRIDGE TO RIVER SECTION 14±
Scale: 1"=10'



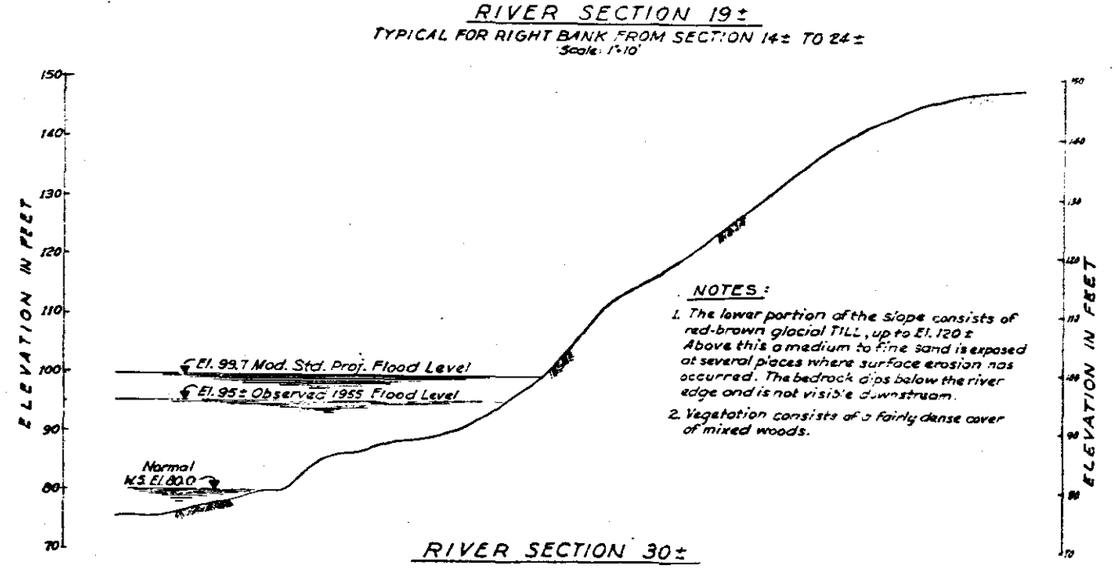
RIVER SECTION 19±

TYPICAL FOR RIGHT BANK FROM SECTION 14± TO 24±
Scale: 1"=10'



RIVER SECTION 24±

TYPICAL FOR RIGHT BANK FROM SECTION 24± TO 26±
Scale: 1"=10'



RIVER SECTION 30±

TYPICAL FOR RIGHT BANK FROM SECTION 26± TO 33±
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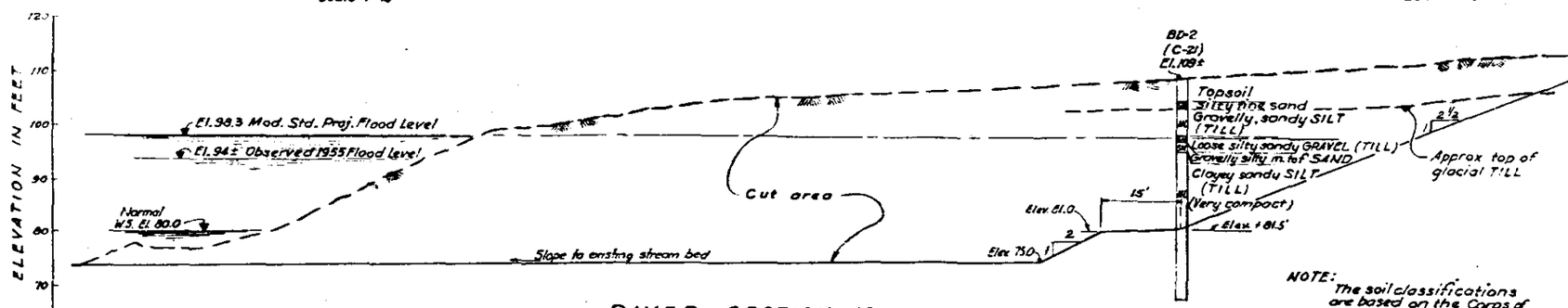


RIVER SECTION 40

TYPICAL FOR MAXIMUM CUT IN AREA DOWNSTREAM OF SECTION 33±
Scale: 1"=10'

NOTE: The soil classifications are based on the Corps of Engineers field logs.

GRAPHIC SCALE 1"=10' — 10 0 10 20

REVISED	DATE	DESCRIPTION	BY

GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS. ARCHITECT-ENGINEER

U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.

DES. BY | DR. BY | CK. BY

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
SPECIAL STUDY OF RIGHT BANK SOILS DATA AND SECTIONS
CHICOPEE RIVER MASSACHUSETTS

APPROVED DATE

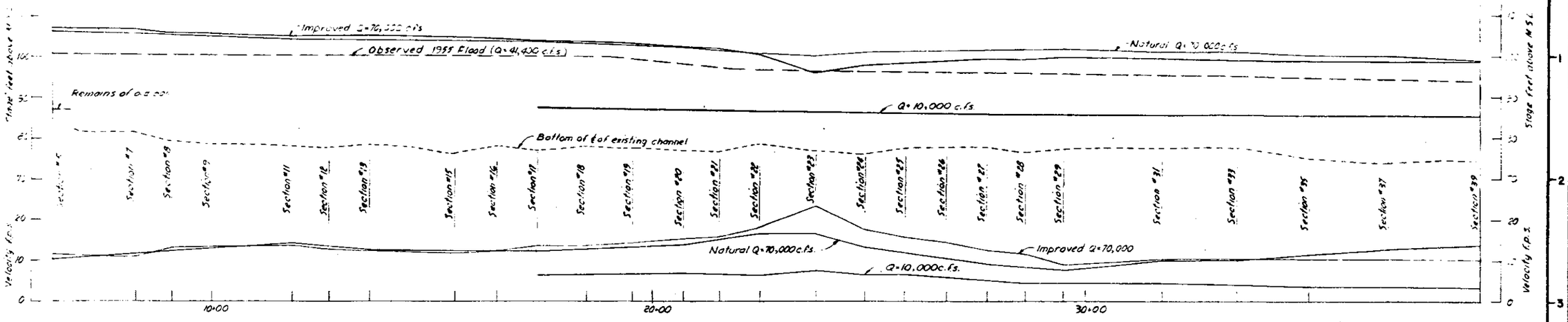
HALEY & ALDRICH, INC. CONSULTING SOIL ENGINEERS CAMBRIDGE, MASS.

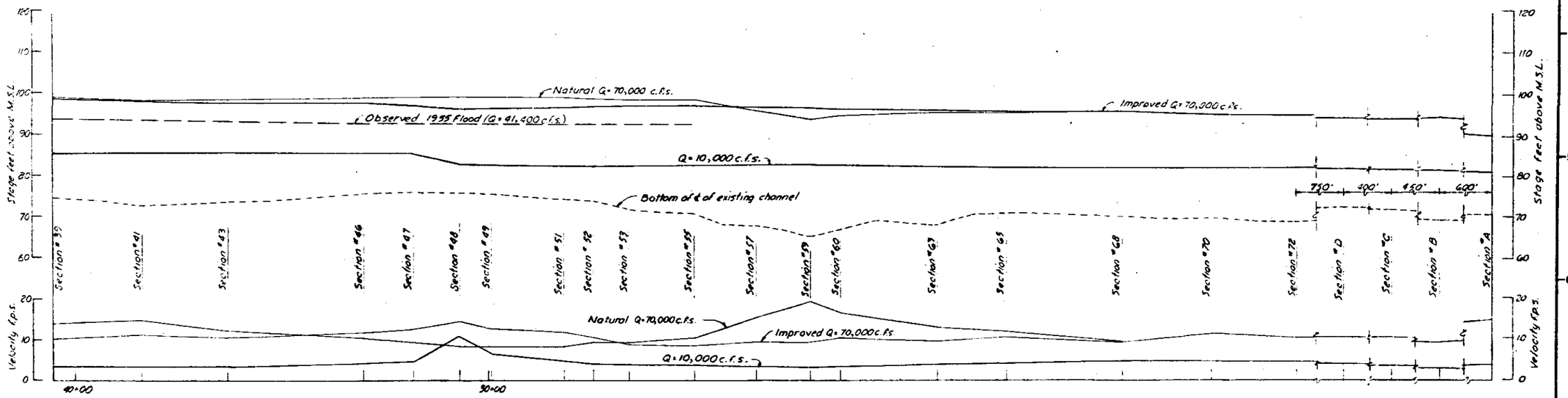
SCALE | SPEC. NO. CIV. ENG-19-096-
DRAWING NUMBER
SHEET

FILE NO. 62-735

PLATE NO. 9

CORPS OF ENGINEERS — U.S. ARMY





PROFILE

SCALES HOR 1"=100'
VERT 1"=10

GRAPHIC SCALE

1"=100' 100 0 100 200

Revision	Date	Description	By
GREEN ENGINEERING AFFILIATES, INC. BOSTON, MASS. ARCHITECT-ENGINEER		U.S. ARMY ENGINEER DIVISION, NEW ENGLAND CORPS OF ENGINEERS WALTHAM, MASS.	
Des. By	Dr. By	Ck. By	
Submitted			
Architect-Engineer			
Project Engineer			
Approved Recommended			
Chief, Engineering Division			
Chief, Operations Division			

CHICOPEE RIVER FLOOD CONTROL
CHICOPEE FALLS
LOCAL PROTECTION PROJECT
[illegible]
CHICOPEE RIVER MASSACHUSETTS

Approved Date

Chief, Engineering Division

Scale | Spec. No. CH. CHS.-10-210-
Drawing Number
Sheet

PLATE NO 4

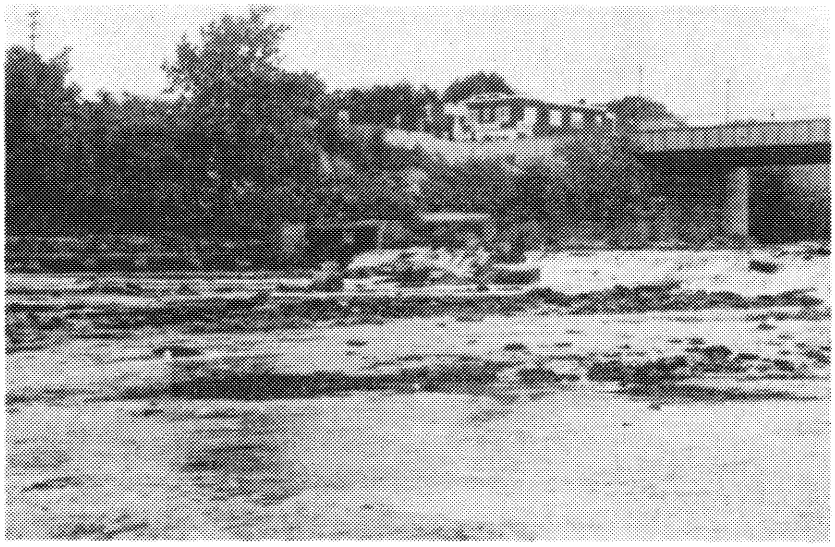


PHOTO #1

Taken from Savage Arms Parking Lot

(Section #7)

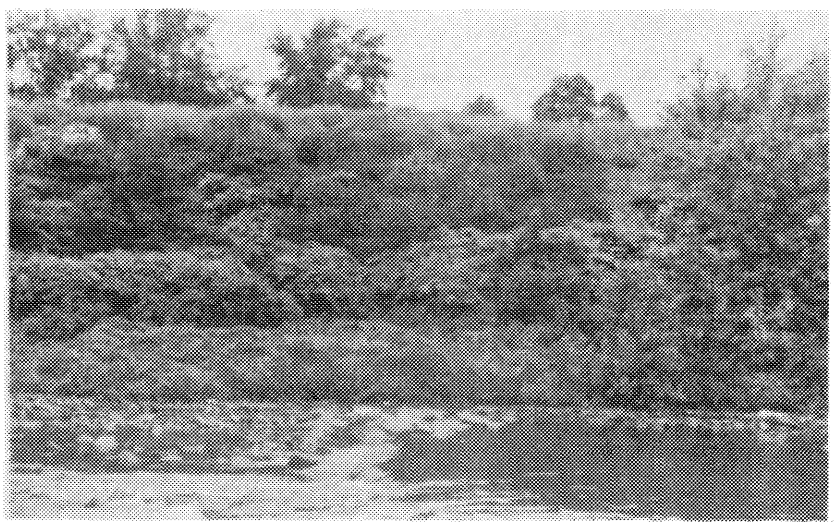


PHOTO #2

Taken from Mill #1 of Chicopee Mfg. Co.

(Section #14)

PLATE NO. 5

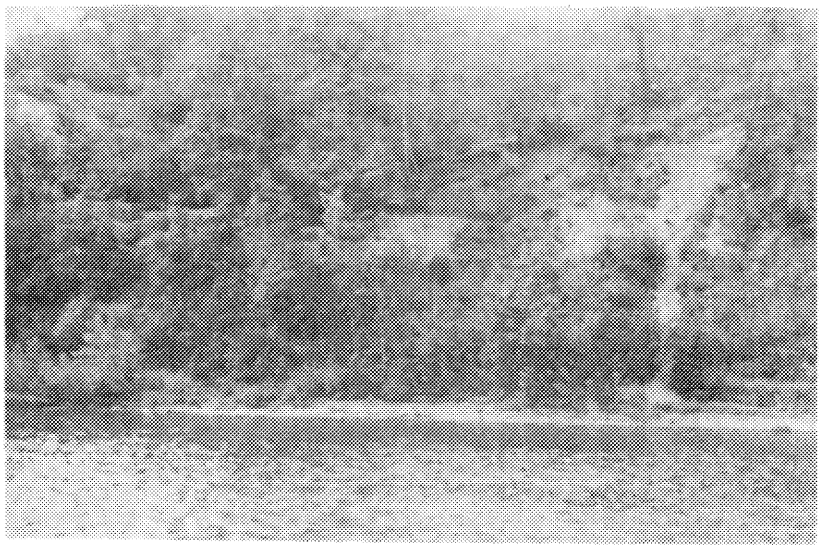


PHOTO #3
Taken from Mill #2 of Chicopee Mfg. Co.
(Section #22)

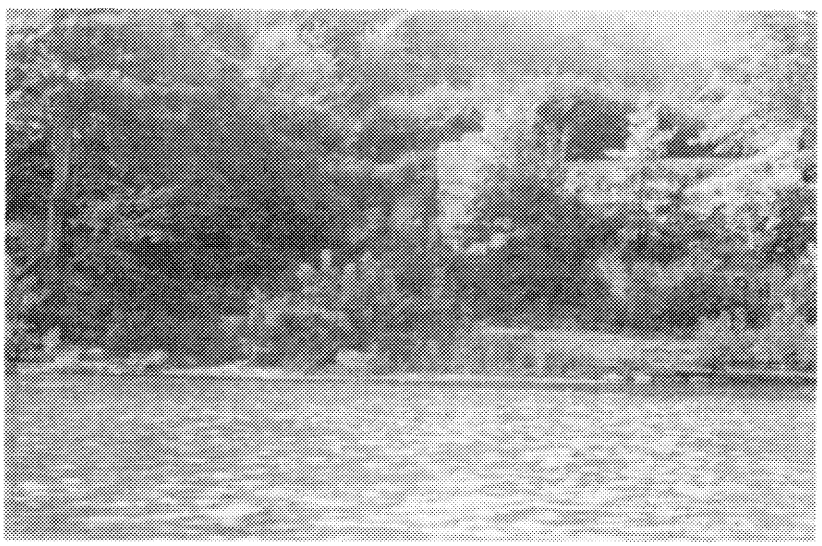


PHOTO #4
Taken from a point 300' downstream from
Mill #2 of Chicopee Mfg. Co.
(Section #24)

PLATE NO. 6

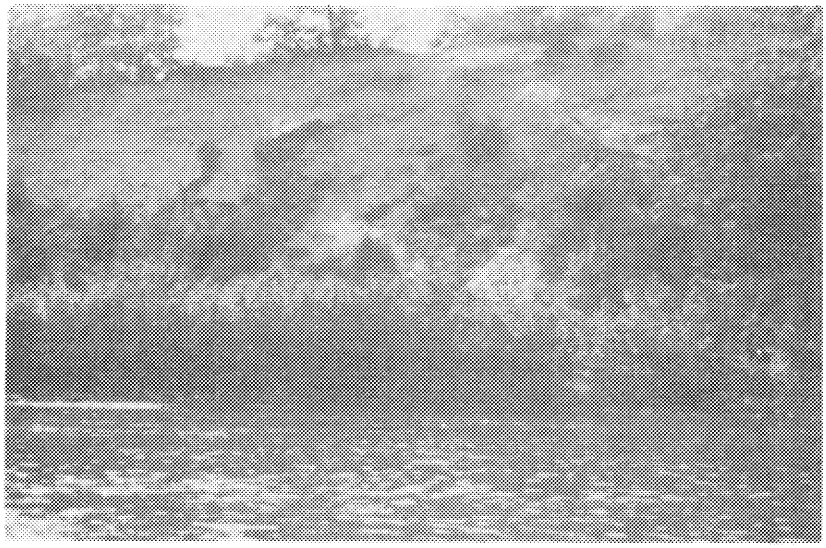


PHOTO #5
Taken from a point 400' downstream from
Mill #2 of Chicopee Mfg. Co.

(Section #25)

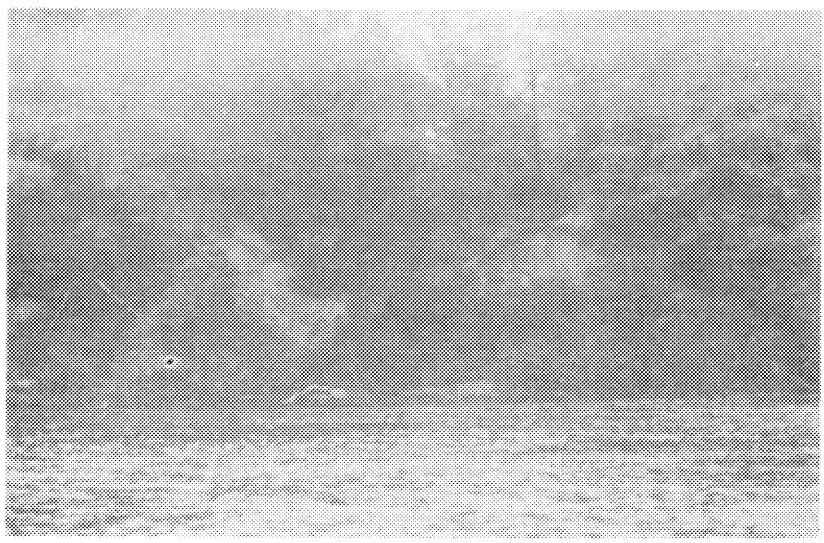


PHOTO #6
Taken from a point 400' downstream from
Mill #2 of Chicopee Mfg. Co.
(Section #25)

PHOTO #7
Taken from a point 400' downstream from
Mill #2 of Chicopee Mfg. Co.,
(Section #25)

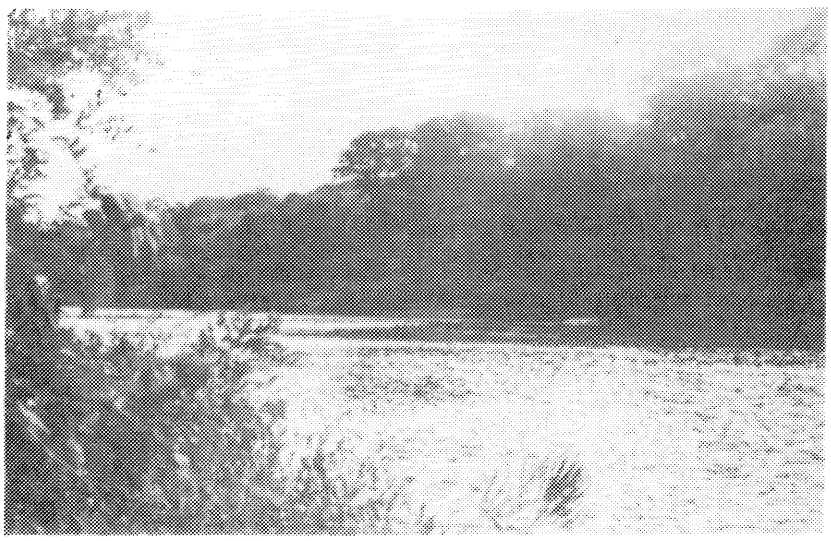


PHOTO #8
Taken from a point 400' downstream from
Mill #2 of Chicopee Mfg. Co.
(Section #25)

PHOTO #9
Taken from the continuation of Oak Street
through U.S. Rubber Co. property
(Section #39)

PHOTO #10
Taken from the continuation of Oak Street
on the property of U.S. Rubber Co.
(Section #39)

PLATE NO. 9